1242378 - R8 SDMS

Prepared for:

U.S. EPA Region 8

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May 2, 2011

SITE BACKGROUND

The Sharon Steel site (EPA ID UTD980951388) is a former ore milling facility in Midvale, Utah. The U.S. Environmental Protection Agency (EPA) added the site to the National Priorities List (NPL) in 1991. Operable Unit 1 (OU1) (approximately 260 acres) is a capped tailings pile with high levels of lead and arsenic, which posed a threat to human health and the environment until it was remediated. Operable Unit 2 (OU2) comprises an adjacent residential and commercial area that has been remediated by removal of contaminated tailings that were present on the properties.

Milling operations at the site began in 1906 and ended in 1971. The milling process extracted compounds of lead, copper, zinc and other metals. The waste from this process resulted in the tailings pile at the site, estimated at 10 million cubic yards and up to 58 feet deep. The ground water was contaminated with arsenic and other heavy metals. The wetlands on the site contained sediments contaminated with arsenic and lead. In 1992 and 1993, EPA demolished the old mill building. In 1995 and 1996, a 190-acre composite cover system was placed over the tailings pile; the capped area also contains the demolished mill buildings, mill foundations and contaminated materials removed from the wetlands and from along the Jordan River. The composite cover system consists of (from bottom to top): compacted subgrade, geosynthetic clay layer (GCL), 30-mil polyvinyl chloride (PVC) geomembrane, a geocomposite drainage blanket, and a compacted soil cover of varying thickness to protect the geosynthetics. The purpose of the geosynthetic and soil cover system is to prevent nearby residents from being exposed to soil and tailings containing high levels of lead and arsenic and ground water containing high levels of arsenic, prevent infiltration, and protect surrounding ecological health. At the time of installation, this was thought to be one of the largest geosynthetic cover systems ever placed.

After cleanup activities were completed, the site was deleted from the NPL in 2004. OU1 is currently vacant and fenced as shown in the photograph on the report cover.

Institutional controls for OU1 are contained in Midvale Municipal Code Ordinance 6/26/2007 O-8, which replaced the 2004 Institutional Control Process Plan. The ordinance describes acceptable development activities for the capped area of the site ("Jordan Bluffs West") and the uncapped area of the site ("Jordan Bluffs East"). The ordinance also prohibits unauthorized ground water wells on OU1.

STUDY OBJECTIVE

EPA Region 8 requested that Skeo Solutions review the site's technical documents, visit the site and draft a report addressing the following questions:

- What land uses can the site's geosynthetic cover currently support?
- What land uses are not feasible or recommended given the cover system in place?
- What, if any, additional information needs to be collected to make a determination?

GEOTECHNICAL ISSUES

This geotechnical review is based on current site conditions; this review is not a critique of past remedy selection decisions as selected in the Record of Decision (ROD) or as implemented during the remedial design and remedial action. A number of geotechnical issues should be considered prior to redevelopment of the site. These geotechnical issues include:

Settlement of the Tailings

Settlement is a key issue for site reuse because it appears that the tailings were not compacted when placed. A 2005 geotechnical investigatfon report prepared for a potential site developer by Applied Geotechnical Engineerihg Consultants (AGEC) "anticipate[s] that the majority of the site contains fine grained and/or compressible tailings." As a result, settlement of the tailings will occur due to: (a) self weight consolidation and compaction, (b) imposed load from structures, and/or (c) imposed load from fill placed on top of the cover system to facilitate development. More important than the magnitude and time rate of total settlement is the amount and location of differential settlement. It is anticipated that differential settlement will be a problem because of the heterogeneity of the tailings, the variable placement techniques used, and the inclusion of demolition debris under the cover. Because of this variability, it is our opinion that even an extensive geotechnical investigation will not be able to fully quantify the magnitude and locations of differential settlement. Therefore, regardless of the reuse approach selected, structures sensitive to differential settlement, such as residential buildings, should not be considered for portions of the covered area that are more prone to differential settlement (referred to as Zones A and B later in this report under Approach No. 2; see Figure 1). In Zones A and B, less sensitive and low-bearing-pressure structures can be built to reduce total and differential settlement and to accommodate the settlement that does occur. Residential buildings are not recommended for Zones A and B because home occupants are usually not receptive to even minor cracking, which can lead to extensive litigation. Based on a review of available borings, it appears that Zone C may undergo less settlement, and thus less cracking, than Zones A and B, so residential buildings may be suitable for Zone C.

Slope Stability

Slope stability is a concern because most of the perimeter slopes are inclined at a slope of about 2:1 (horizontal:vertical); typically geosynthetic-lined and uncompacted slopes are inclined at 3:1 for stability purposes. These slopes may experience movement during a heavy rainfall or seismic event. In fact, two slope failures did occur during remedial action work in 1995 and1996 due to

saturation of the tailings and the soils at the toe of the slope; these areas were adjusted to a 3:1 slope to prevent further slope failures. To protect future reuses from being damaged by slope failures, prudent setbacks from the top of the slopes should be used. Typical ratios of depth of slide surface to slide length are less than 0.4 for circular slides, which is the anticipated failure mode for the tailings. Along the Jordan River, the western slope is about 50 feet high (elevation 4240 to 4290 feet) at a 2:1 inclination. This corresponds to a depth of sliding of 45 to 50 feet for a slope length of about 120 feet. A slope setback of 100 feet could be used to minimize the potential for a slide surface undermining a structure. Although typical slope setbacks (such as those in California) are one-third to one-half of a slope's height, a more conservative setback of 100 feet is suggested for this site because the slope material at Sharon Steel consists of under- to normally-consolidated tailings and limited subsurface information is available. If sufficient geotechnical information is developed and a suitable factor of safety is available, the proposed slope setback of 100 feet could be reduced.

The alluvial soils underlying the tailings have probably been consolidated due to the weight of the overlying tailings, so a foundation-type failure is not anticipated unless the applied load from reuse is significantly greater (such as the load from a multi-story building) or extensive liquefaction occurs due to a large earthquake. If the reuse applied load is significant or extensive liquefaction is anticipated, a slope setback greater than 100 feet should be used. To reduce the slope setback and decrease the risk of foundation failure, the stability of the slope along the Jordan River could be increased by constructing a small earthen or landscape rock berm along the slope toe. An appropriate height for the berm would be one quarter of the slope height. Landscaping along the slope toe can be undertaken but should not increase the amount of water that can infiltrate the slope or foundation materials, because this could decrease slope stability. Reducing the steepness of the slope to increase slope stability is probably not feasible because of limited space at the toe of the slope where the paved recreational trail lies and because laying back the slope at the top of the cover system would interfere with the existing geosynthetic cover.

Seismic Concerns

A number of seismic concerns exist for this site, including applicable design ground motion/acceleration, liquefaction of the tailings and underlying alluvial soils, and seismic slope stability and deformation. Any reuse will have to meet the seismic requirements of the International Building Code, as amended by Utah. Midvale is located in seismic zone D2, which sets the level of shaking that the tailings pile and any structures must be able to resist. Liquefaction of the tailings could cause a loss of foundation support and settlement of structures constructed on the tailings, as well as slope instability along the Jordan River side of the tailings pile. Liquefaction of the underlying alluvial soils also could lead to slope instability along the Jordan River side of the tailings pile. Even if liquefaction does not occur, earthquakes can cause slope instability along the Jordan River side of the tailings due to the imposed inertia forces.

However, it is anticipated that the proposed slope setback should be sufficient to prevent damage to structures on top of the tailings pile.

Detailed Subsurface Investigation

The geotechnical issues discussed above are exacerbated by the lack of a comprehensive geotechnical investigation for the site. Because a detailed subsurface investigation has not been conducted, the analyses performed to date have considerable uncertainty associated with them. For example, actual settlement could deviate by 50 to 100 percent from the calculated values based on limited existing data. The uncertainty about settlement could be reduced by comparing the results of the four existing preloads on the site with calculated values. In response to a reuse proposal that involved a residential and commercial development across most of the site, a 2007 geotechnical review conducted for the City of Midvale by HDR concluded that a detailed subsurface investigation would be necessary:

> The scope of the geotechnical investigation of the development is insufficient to properly characterize subsurface conditions over the 270-acre Site area, based on current practice. Based on available guidance regarding minimum scope of geotechnical field investigations for residential, commercial and municipal projects obtained from selected sources within the western U.S., investigative density should be a minimum of one boring for every two to four acres of site area, and one boring for each multi-story building, 5,000 square feet or greater.

Some of the parameters that would have to be determined during a detailed subsurface investigation include:

- Areal water level data throughout the tailings pile for settlement, allowable bearing pressures, slope stability and liquefaction analyses.
- Engineering properties of the tailings throughout the tailings pile.
- Engineering properties of the native material underlying the tailings pile.

The drilling and sampling cost for such a subsurface investigation would be $200,000 to $300,000. This cost does not include testing, analysis, design, specification and any ground improvements that would be needed before redevelopment could proceed.

Geosynthetic Cover Issues

The tailings pile is covered with a 190-acre composite cap which includes three layers of geosynthetics: a geosynthetic clay layer, a 30-mil PVC flexible membrane liner (FML) and a geocomposite drainage blanket. The main objectives of the cover system, as detailed in the 1993 EPA Superfund Record of Decision, were to:

- Prevent exposure to contaminated soil/tailings on the site by isolating tailings and soil exhibiting contaminant concentrations exceeding health-based remediation levels.
- Prevent migration of and exposure to contaminated ground water exhibiting arsenic concentrations greater than the action levels beyond the boundaries of the OU1 site.
- Prevent exposure to contaminated soil/tailings, reduce inflow of water to the tailings, and reduce further contamination of the shallow ground water by construction of a cap and interceptor trench.

It is anticipated that the flexible membrane liner both aids and complicates reuse of the site. The FML aids development by controlling infiltration and ground water contamination, preventing people from coming into contact with the contaminants, and allowing a well-irrigated reuse. The FML complicates reuse because of its susceptibility to penetrations, tensile stresses and puncture. However, compared to other FML material types, the 30-mil PVC used at the site is less susceptible to damage due to settlement, puncture, tensile stresses and degradation (Stark et al., 2004; Stark et al., 2008; Stark and Newman, 2009). In addition, PVC FMLs are easily and effectively repaired using solvent patch welding (Thomas et al., 2003).

Protecting the FML during redevelopment is important. Damage to the FML during or after construction may cause some or all of the following to occur:

- Increased infiltration, leachate generation, and ground water and Jordan River impact.
- Increased liquid in tailings which could cause more settlement, lower allowable bearing pressure, decreased slope stability, increased liquefaction potential and damage to the remaining cover system.
- Increased possibility of human or biota contact with contaminated material.

REUSE CONCERNS AND RECOMMENDATIONS

The Sharon Steel site's OU1 is a large vacant parcel surrounded by developed areas. Some of the many positive attributes of the site that may increase development possibilities include:

- Site is on a bluff overlooking the Jordan River and has an excellent and unobstructed view of the Oquirrh Mountains to the west.
- The new TRAX light rail station just west of the site offers an additional option for commuting to Salt Lake City.
- Interstate highways 15 and 215 can be accessed within 2 miles of the site.
- The Jordan River Parkway, a paved recreational trail, runs along the western edge of the site, between the covered area and the Jordan River.
- Substantial commercial and residential reuse of the adjacent Midvale Slag site is underway.

Because an extensive geotechnical investigation has not been conducted, there is considerable uncertainty regarding the geotechnical properties of the tailings pile. Three potential approaches for coping with this uncertainty are presented below.

Aoproach No. 1 – Extensive Gedtechhical Investigation

This was the approach recommended in response to a reuse proposal that involved a residential and commercial development titled "Prbposed Jordan Bluffs Development." The main geotechnical issues that would have to be addressed before full-scale residential and commercial reuse iiiclude: settlement, slope stability, seisinic potential, subsurface investigation and allowable bearing presstures. The cbndition of the geosynthetic layers would need tb be verified and the inipact of development on the layers would need to be investigated, including longevity, penetrations and patches, tensile stresses and differential settlement.

- **Advantages of Approach No. 1:**
  - Extensive geotechnical investigation woidd determine what ground improvements would be needed to allow for a wide range of reuses.
  - Tlus approach woidd pmpare the site for the widest range of reuses, across the largest area.
  - Addressing all geotechnical issues is consistent with other developments and approvals.

- **Disadvantages of Approach No. 1:**
  - An extensive geotechnical investigation, which would be expensive and lengthy, would have to be imdertaken before any revenue is generated from the site.
  - The PVC flexible membrane liner would be pimotured by the many borings that would be needed to assess the engineering properties of the tailings and native material under the tailings, as well as by accidental penetrations during construction. These punctures would require niany patches of the flexible membrane liiier. PVC flexible membrane liners exhibit better patehing pei fonnance than other types of FML material but, if these patches fail, contaminant migration pathways to the ground water would result.
  - The geosynthetic layers would be at risk of damage due to tensile stresses induced by differential settlement.
  - Extensive subsurface investigation will prpbably indicate that a substantial portion of the site must be improved befdre a wide range of reuses are possible. For example, AGEC's 2005 geotechnical investigation recommends preloading about 75% of the site. However, even after such ground improvement is performed, some additional subsurface investigation and analysis would be required to ensure that the needed improvement was achieved.
  - Even after expensive investigation, geotechnical uncertainties would remain because of the variety of materials located under the cover system (ineluding mill foundations,

demolition debris, river sediment and variable tailings) and the variable methods of placement and compaction.
- Installation of utilities in the covered area may require additional soil to be placed on top of the cover to house the utilities.

- Operation and Maintenance (O&M) for Approach No. 1:
  - The O&M that would be required for this approach depends on the reuse, ground improvement methodology used (e.g., pre-loading), foundation systems used and condition of the FML cover. For example, if the site is not pre-loaded settlement will occur and the FML may be subjected to tensile stresses, especially near the anchor trenches, that may damage the liner and any patches. If the site is preloaded or lightly loaded so that it does not undergo a substantial amount of settlement, the O&M of the FML should be minor and simply consist of periodic inspections.
  - Depending on the level of ground improvement and foundation systems used, repairs may be needed after a seismic event.

Approach No. 2 – Pursue Zone-Specific Reuses That Can Be Implemented Without an Extensive Geotechnical Investigation

Approach No. 2 aims to identify reuse types that can be implemented without the extensive subsurface investigation, testing, design and ground improvement that would be required under Approach No. 1. Under Approach No. 2, the site is divided into different zones based on likely geotechnical attributes; compatible reuse types are suggested for each of these zones. Figure 1 roughly identifies four zones, which are each discussed below with some possible reuse types for each zone. The boundaries between the four zones were drawn based on the boring logs and cone penetration soundings presented in AGEC's 2005 geotechnical investigation. The borings and cone soundings were used to identify areas of thin and thick deposit or depths of tailings. In general, Zone A is located in areas of the greatest thickness of tailings or areas of the most compressible tailings, Zone C is located in areas of little to no tailings, and Zone B is located in intermediate areas. Areas with little or no tailings will allow heavier structures than areas with a large depth of tailings. Zone D consists of the slopes along the northern, western and southern boundaries of the site, as well as a 100-foot setback at the top of the slopes to protect improvements from possible slope instability.

- Zone A: Lightly Loaded Area (approximately 73 acres)[1]
  "Lightly loaded" refers to the pressure applied by the proposed reuse. In this zone, deep foundation systems are not recommended. Deep foundation systems, such as piles, piers, drilled shafts, and grout or stone columns, are not recommended because they would require penetrations of the geosynthetics in the cover system. Furthermore, the tailings

[1] The approximate acreages of the four reuse zones do not sum to equal the total acreage of OU1 because parts of OU1, such as the wetland, are not included within any of these four zones.

are probably still undergoing settlement, so the tailings could settle more than the structure, leaving a gap below the structure as has occurred on at least one redeveloped landfill. Structures that can be supported on spread footings or a raft foundation should be considered for this zone. These include: car dealerships, photovoltaic solar panels, athletic fields, skateboard parks, drive-in theaters, sculpture or botanical gardens, parking lots, cemeteries, green space and plant nurseries/greenhouses. The largest concentrating photovoltaic solar power facility in the country has been built on a tailings area at the Molycorp, Inc. NPL site in Questa, New Mexico.[2] Solar panels have also been installed on landfill covers in Texas (Republic Services, Inc., 2009) and Georgia.

- **Zone B: Lightly to Medium Loaded Area** (approximately 82 acres)
  Deep foundations are also not recommended for this zone; spread footings or raft foundations should be used. Potential reuse types include: light industrial parks, one- to two-story office space, athletic stadiums, amphitheaters, big box retail, outlet shopping malls, self storage units, single-family homes, electric substations and animal shelters. It should be noted that some big-box retailers, such as Walmart, Sam's Club and Home Depot, have already built stores on closed landfill sites.

[2] http://www.epa.gov/superfund/programs/recycle/live/region6_nm.html

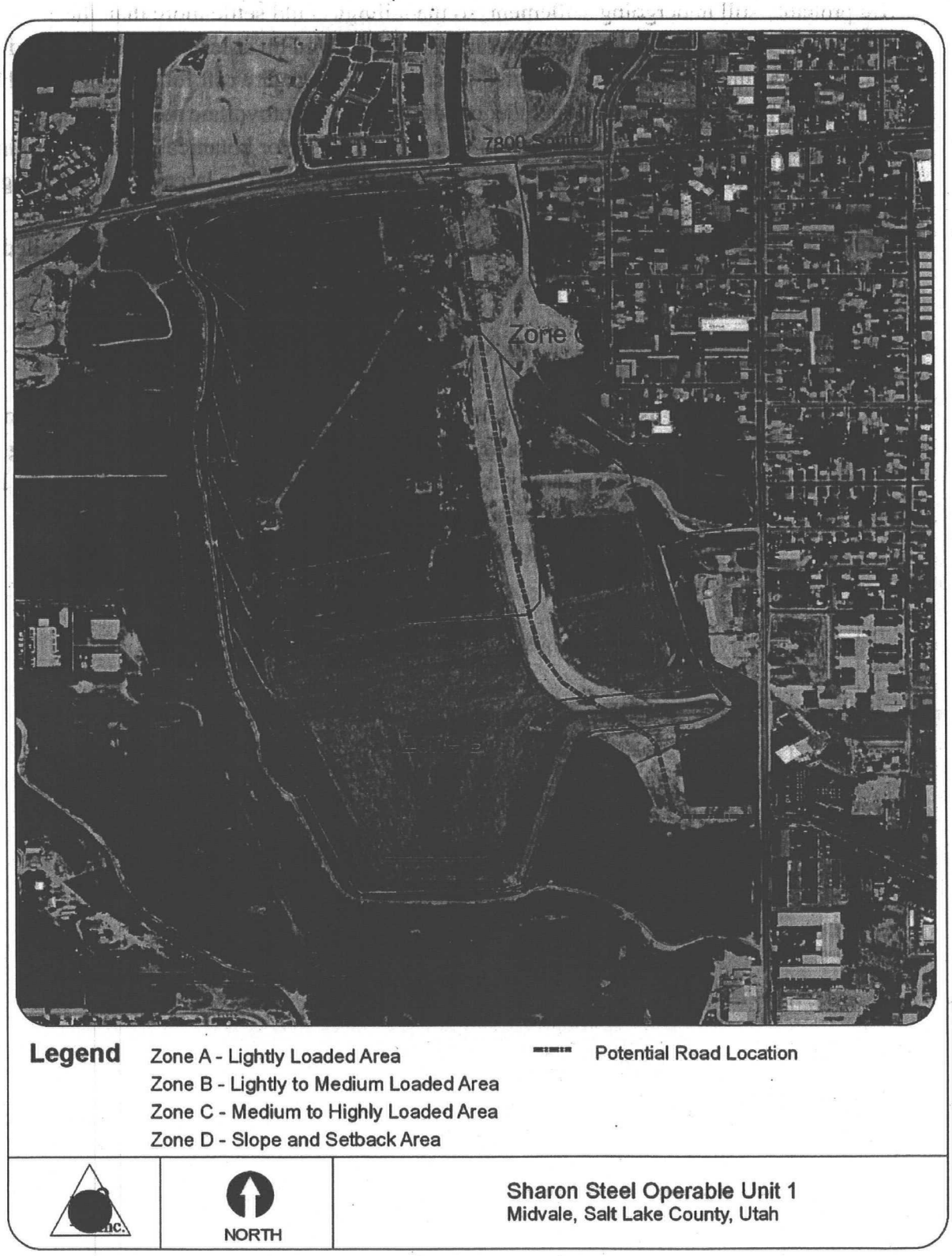

Figure 1. Approach No. 2 - Specific Reuse Zones.

- **Zone C: Medium to Highly Loaded Area** (approximately 40 acres)
  Reuses in this zone ideally would still be supported using spread footings or raft foundations, bnt deep foundations could be used in most of this zone because it is not underlain by the geosyntnetic coyer system. Some of the possible reuses in this area include: nid- to high-rise conmercial or residential, office and industrial parks, hotels/motels, govemment centers, jails, maintenance faeilities, and public works or other municipal facilities.

- **Zone D:** Slope and Setback Zone (approximately 39 acres)
  Figure 1 shows a 100-foot wide setback zone that rms along the top of the slopes of the geosynthetic covered area. A slope setback of 100 feet should be observed because of the under- to normally-consolidated nature of the tailings and the limited subsurface infbrmation available. In this zone, some possible reuses include: photovoltaic solar panels along the western and southern slopes of the tailings pile, skateboard parks, sledding slopes, bicycle and jogging paths, pet trails and wetland observation platforms.

Trial Phase

To facilitate development and to investigate the response of the tailings and geosynthetic cover system to development, a trial phase of development coidd be initiated. The geotechnical mvestigation for the trial phase would eost less than for commercial structures. For example, the proposed extension of Bingham Junction Blvd. shown in Figure 1 (see dashed red line) could be constructed first to improve site access, reduce development costs for the developer, and better understand the response of the tailings and cover system to development. As shown in Figure 1, the potential road crosses all four zones, and crosses both covered and uncovered areas; this would provide a rough gauge of the site's differential settieinent. A flexible pavement should be used because of the inevitable settiement and eraeking. The road should descend the steep slope at the south end bf the tailings pile at a diagonal to accommodate winter driving conditions. If sufficient thickness of cover soil is present on the geosynthetics (about 24 inches), construction of the road should not damage the geosynthetic cover although it may undergo some settlement. The 30-mil PVC geomembrane and underlying GCL can accommodate some settlement. Other possible trial phase reuses include: skateboard parks, photovoltaic solar panels, athletic fields, parking lots, and bicycle and jogging paths.

- **Adyamtages of Approach Np. 2:**
  - This approach will entml a lower overall project cost.
  - The initial cost and time for a geoteclmical investigation will be less than under Approach No. 1.
  - Reuse can be achieved sooner.
  - Minor geotechnical uncertainties will remain for Zone C.
  - City has control over this approach via existing zoning ordinances.

- Disadvantages of Approach No. 2:
  - There is a smaller range of possible reuses than under Approach No. 1.
  - Depending on the reuse, ground improvement may be needed, such as pre-loading or removal of some tailings to increase consolidation and improve engineering properties of the tailings.
  - Installation of utilities in Zones A and B may require additional soil to be placed on top of the cover system to house the utilities depending on the current soil cover thickness.

- Operation and Maintenance for Approach No. 2:
  - Repairs may be needed after a seismic event.

<u>Approach No. 3 – Pursue Reuses That Can Be Implemented With Cover System Modification</u>

This approach is presented as an alternative to Approaches No. 1 and 2 and seeks to remove some of the complications created by the geosynthetic cover system. The essence of this approach is to modify the cover to facilitate development and/or add additional protections to ensure that the objectives of the cover are achieved. Note that BPA may not legally be able to pay for modifications of the remedy currently in place; also, any such modification to the existing remedy may require the existing EPA decision documents to be modified before this approach could be implemented.

Possible Cover System and Site Modifications

This section presents some possible cover system and site modifications that could be performed to facilitate development of the site. These modifications are designed to reduce the concerns or complications associated with the FML cover system. These modifications include:

- Install a new geosynthetic cover in areas that require site preparation/ground modification or penetrations. Current pricing of a 30-mil PVC FML installed is about $10,000 per acre; however, the price is highly variable. Existing PVC FML can be easily welded to new 30-mil PVC FML to re-establish an impermeable cover.
- Install a new alternative cover system that does not use an FML, either across the entire capped area or in certain areas; this cover system would make the current geosynthetic cover superfluous. This alternative cover system would consist of several layers of soils and would achieve all of the objectives of the current cover system. This type of cover system, referred to as either an unsaturated soil cover or an evapotranspirative cover, has been recently used to cover the hazardous waste landfills at the Rocky Mountain Arsenal (Williams et al., 2011). This cover system could consist of the following layers, from top to bottom: vegetative layer, 3 to 4 feet of unsaturated soil, a capillary barrier which prevents infiltration (consisting of a non-woven geotextile and 1 to 3 inches of pea gravel), a biointrusion component which prevents biota from reaching the waste (could consist of crushed concrete), and fill

material to establish necessary site grades. This type of cover system would allow the installation of utilities across the site and may allow the use of deep foundations. If the tailings are expected to undergo settlement after installation of the cover system and other aspects of the reuse, the settlement should be allowed to occur before the piles are driven so a gap does not form below the pilo-supported structure. Given the uncompacted nature of the tailings, it is doubtful that the tailings would not settle to some extent in response to the weight of an evapotranspirative cover.

- If the FML is removed or damaged, install a groimd water control system along the toe of the tailings pile to prevent contaminated ground water from reaching the Jordan River. Depending on where the breach in the FML occurs, contaminants eould be transported vertically below die tailings pile and into a deeper aquifer. If the ground water flow regime would allow this vertical or near vertical migration, the FML should be repaired by welding new PVC FML to the existing PVC FML as described above.
- Preloading, the easiest method of ground improvement, may be desirable for Zone B. The light to medium loading proposed for Zone B cotdd induce settlement if the area is not preloaded. If the proposed structures in Zone B will not induce significant differential settlement, preloading would not be required. Preloading is probably not necessary in Zone A, because this zone corresponds to open space or lightly loaded structures which probably will not induce a large anount of settlement. It is anticipated that preloading will be suitable for the FML because the tailings will settle under the preload so, in general, the FML will not be placed in tehsion. However, there may be areas that undergo tension due to variability in the tailings oi applied load. Additional subsurface mvestigation and analysis would be requined to ensure that the needed improvement was achieved by the preloading.
- Another way to effectuate a preload is to remove some of the tailings, which would lower the tpp elevation of the pile, and then re-weld the FML. The remaining tailings and underlying alluvial soil would be stronger for development purposes because the removed tailings would have acted as a preload.

- Advantages of Approach No. 3:
  - Site preparation cpuld proceed more quickly and at less cost, cpmpared to Approach No. 1's extensive geoteclmical inyestigation and associated site improvements.
  - Installation of an alternative cover would facilitate future redevelopment because construction actiyities would not need to avoid damaging the existing FML and sufficient spil wpuld be present to accommodate utilities.
  - Site woidd be ready for more types of reuses than under Approach No. 2 because utilities could be easily installed and penetrations in the existing FML cpuld be made if the cover system is going to be replaced. These reuses could include ail of the reuses included above for Zones A, B and C if the site is preloaded.

- If settlement is not a problem and an alternative cover system is used, pile foundation systems may be possible.

- Disadvantages of Approach No. 3:
  - Cost and time for modifying cover system could be significant.
  - Site may not be ready for every possible reuse.
  - Geotechnical uncertainties would still remain.
  - Deep foundation systems may not be advisable unless the site is preloaded and the majority of the settlement is removed prior to installation of the deep foundations so that settlement does not occur around and below the pile-supported structure.
  - Modifying the cover system would require additional time for Superfund analysis, as well as issuance of a decision document (ROD Amendment or Explanation of Significant Differences (ESD)).
  - Repairs may be needed after a seismic event.

- Operation and Maintenance for Approach No. 3:
  - A new geosynthetic cover would require little additional O&M.
  - An evapotranspirative cover system requires frequent monitoring until the vegetation is fully established in the vegetative layer. Afterward, monitoring of the cover consists of visual observations for erosion, vandalism and burrowing animals, inspection of the vegetation (evaluate distress, presence of weeds or bare areas, establishment of seeded species, overgrazing, etc.), and possibly some percolation monitoring to ensure infiltration is not reaching the tailings.

SUMMARY AND RECOMMENDATIONS

EPA Region 8 requested that Skeo Solutions review technical documents prepared for Sharon Steel's OU1, visit the site and draft a report addressing the land uses that the site can support from a geotechnical perspective. This report describes the geotechnical issues of concern at the site and describes three potential reuse approaches to deal with the site's geotechnical uncertainties. Under Approach No. 1, an extensive geotechnical investigation would be conducted for the entire site; this investigation would determine what ground improvements would be necessary prior to redevelopment. After carrying out these ground improvements, the site would be suitable for the widest range of reuses, across the largest area. Under Approach No. 2, the site would be divided into zones based on geotechnical properties and reuse types appropriate to each zone would be pursued. This approach would involve less geotechnical investigation than under Approach No. 1 and reuse could proceed immediately. Under Approach No. 3, the cover system would be modified, allowing a greater range of reuse options than would be possible under Approach No. 2. However, modifying the cover system would cost more and take longer than using the zone approach. It would also be possible to use a combination of the three potential reuse approaches; for example, an extensive geotechnical investigation (Approach

No. 1) focusing on one of the zpnes (Approach No. 2) may conclude that a modification of the cover system (Approach No. 3) is desirable.

The borings required under Approach No. 1 would entail many pmictures and subsequent patches of the geosynthetic layers in the cover system. Furthermore, many geotechnical uncertainties would remain even after this expensive and time-consuming geotechnical investigation. Therefore, this review recommends that Approach No. 2 or No. 3 be pursued (or a combination of Approaches No. 2 and 3 with the necessary geotechnical investigation), rather than Approach No. 1. The City of Midvale and potential developers would need to work closely witb EPA and the Utah Depaitment of Environmental Quality (UDEQ) to pursue any redevelopment approach. Given that EPA has already implemented a protective remedy at the site, EPA may not legally bc able to fund modifications of the remedy.

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